SECTION 2000--CONCRETE

2001 SCOPE. This section covers all cast-in-place concrete, including reinforcing steel, forms, finishing, curing, and other appurtenant work.

2002 GENERAL. All cast-in-place concrete shall be accurately formed, and properly placed and finished as shown on the drawings and specified herein.

Where governing specifications are referred to, material and construction requirements shall conform to the governing specification as modified herein. "KHS" shall refer to Standard Specifications for State Road and Bridge Construction, Kansas Department of Transportation, 1980 edition, or latest revision.

The contractor shall inform the engineer at least 24 hours in advance of the times and places at which the concrete is to be placed.

2003 MATERIALS. All material used in the manufacture of concrete shall conform to the following:

Cement: ASTM C150, Type I, II or III (For concrete pavement see Section 1400)

Water: Clean and free from deleterious substances.

Fine Aggregate: KHS Section 1102, Type FA-A, except that artificial or manufactured sand will not be acceptable.

*Coarse Aggregate: KHS Section 1102. Additionally, all crushed stone used as aggregate for concrete requiring a 4000 psi strength shall be obtained from quarries and beds designated by the Kansas Department of Transportation as meeting durability requirements of Class 1 or Class 6, as shown on the current listing on file in the office of the city engineer. Certification by an independent testing laboratory that the aggregates used were obtained from an approved source and identifying the name and location of the quarry and bed number shall be filed, at the contractor's expense, with the city engineer.

Curing Membrane: Type 2-White Pigmented compound, AASHTO Designation M148

Air-Entraining Agent: ASTM C260

Admixtures: ASTM C494

Reinforcing Steel: ASTM A615; Bars, Grade 60, Beam stirrups & column ties, Grade 40

Welded Wire Fabric: ASTM A185, and AASHTO Designation M55

2004 PRELIMINARY REVIEW. A report shall be submitted to the engineer prior to the placement of concrete and shall include data on proposed use, design strength, concrete mix proportions, maximum water/cement ratio, slump designated at the point of delivery, the percent of air in the concrete for air-entrained concrete, and the fine and coarse aggregate gradation. Mix proportions shall be selected preferably on the basis of field experience and may be adjusted upon approval of the engineer where required to produce concrete of proper workability, uniform consistency, and acceptable density and strength. Failure to get a mix design approved from the engineer prior to concrete placement is just cause for removal of the concrete.

When specifically required by the engineer, a tentative concrete mix shall be designed and tested for each size and gradation of aggregate and for each slump intended to be used on the work. Design quantities and test results of each mix shall be submitted to the engineer for review and approval.

2005 CONCRETE MIX DESIGNATIONS. The following tabulation indicates minimum strengths for the various types of concrete which will be accepted.

MINIMUM COMPRESSIVE STRENGTH

CLASS	7 DAYS	28 DAYS	SLUMP
I	2000 psi	3000 psi	4 inches maximum
II	2650 psi	4000 psi	2-4 inches maximum

All cast-in-place or precast construction, unless otherwise stated in these specifications or allowed by the engineer, shall be of Class II concrete. When high-early strength cement is to be used for concrete, the mix shall obtain a 7-day strength not less than the minimum 28-day strength specified to concrete of the same class.

2006 LIMITING REQUIREMENTS. Each concrete mix shall be designed and concrete shall be controlled within the following limits.

		MAX. SIZE	CEMENT	MAX. WATER	MAX. GALS.
		COURSE	CONTENTS	CEMENT	WATER PER
	SLUMP	AGGREGATE	LBS./C.Y.	WEIGHT RATIO	SACK OF CEMENT
CLASS I (3000 psi)	4”	1”	480	.542	6.12
CLASS II (4000 psi)	2”	1”	558	.421	4.75
	3”	1”	588	.421	4.75
	4”	1”	618	.421	4.75

The quantity of portland cement shall be not less than that shown in the preceding table.

Concrete slump shall be kept as low as possible consistent with proper handling and thorough compacting. Maximum slump for portland cement concrete pavement shall be two inches (2”). Slumps for concrete work other than pavement construction shall not exceed four inches (4”). Use of slumps in excess of those specified shall be only when authorized by the engineer. The use of water to obtain so-called "improved workability" shall not be permitted.

The initial set as determined by ASTM C403 shall be attained 5-1/2 hours, plus or minus one hour, after the water and cement are added to the aggregates. If such use has been approved by the engineer, the quantity of retarding or accelerating admixture shall be adjusted to compensate for variations in temperature and job conditions.

The use of admixtures other than air-entraining agents is discouraged and shall not be allowed without the express approval of the city engineer. When approved for specific purposes the admixture content shall be in accordance with the recommendations of the manufacturer for compliance with these specifications.

The total volumetric air content of concrete after placement shall be six percent (6%), plus or minus one percent (1%).

The minimum acceptable compressive strengths shall be as determined by ASTM C39.

As the work progresses, the engineer reserves the right to change the proportions from time to time if conditions warrant such changes to produce a satisfactory job. Any such changes may be made within the limits of the specifications at no additional compensation to the contractor.

2007 BATCHING AND MIXING. Concrete shall be furnished by an acceptable ready-mixed concrete supplier and shall conform to ASTM C94.

The consistency of concrete shall be suitable for placement conditions. Aggregates shall float uniformly throughout the mass and the concrete shall flow sluggishly when vibrated or spaded. The slump shall be kept uniform.

2008 PLACEMENT. The limits of each concrete pour shall be predetermined by the contractor and shall be acceptable to the engineer. All concrete within such limits shall be placed in one continuous operation.

Before concrete is placed, forms, reinforcements, and embedments shall be rigidly secured in proper position and all dirt, mud, water and debris shall be removed from the space to be occupied by the concrete. Bonding surfaces shall be cleaned of all foreign material and shall be free from laitance. Concrete shall not be placed on frozen subgrade or in excavations which have not been dewatered.

Placement of concrete shall conform to requirements of ACI 304. Concrete shall be placed within forty-five (45) minutes of mixing operations, with the exception that the engineer may extend the period to ninety (90) minutes (maximum) dependent upon weather conditions.

Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. Concrete shall not be placed in horizontal layers exceeding eighteen inches (18”) and shall not be deposited in large quantities at any point in the forms and then run or worked along the forms, thus causing segregation of the materials. During and immediately

after placement, concrete shall be thoroughly compacted and worked around all reinforcements and embedments and into the corners of the forms. The concrete shall be vibrated or spaded to produce a solid mass without honeycomb or surface air bubbles.

Where steep slopes are required for placing concrete with chutes, the chutes shall be equipped with baffle boards or be in short lengths that reverse the direction of movement. Chutes, troughs and pipes shall not be made of aluminum.

Concrete shall not be dropped in the forms a distance of more than five feet (5'), unless confined by chutes of pipes; and care shall be taken to fill each part of the form by depositing the concrete as near final position as possible. After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of projecting reinforcement.

2009 COLD WEATHER CONCRETING. Unless authorized in writing by the engineer, mixing and concreting operations shall be discontinued when the descending air temperature in the shade and away from artificial heat reaches 40°F or when forecast to drop below 40°F within 24 hours of placement, and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F.

When concrete work is authorized during cold weather, the aggregates may be heated by methods approved by the engineer prior to being placed in the mixer. No ingredient that is frozen or contains ice shall be placed in the mixer. The temperature of the concrete shall be not less than 60°F and not more than 80°F at the time of placement in the forms. Under no circumstances shall concreting operations continue when the air temperature is less than 20°F. No concrete shall be placed on frozen subgrade. Sudden cooling of concrete shall not be permitted. Concrete injured by frost action or freezing weather shall be removed and replaced at the contractor's expense.

2010 HOT WEATHER CONCRETING. The provisions of this section shall apply to all concrete work which is done when the air temperature is above 80°F at the time of placement.

The temperature of the concrete, when placed, shall not be high enough to cause excessive loss of slump, flash set or cold joints. In no case shall the temperature of the concrete, when placed, exceed 90°F. Forms, reinforcing and subgrade surfaces against which the concrete is to be placed shall be wetted down immediately before placement.

When the air temperature exceeds 90°F and as soon as practicable without causing damage to the surface finish, all exposed concrete shall be kept continuously moist by means of fog sprays, wet burlap, cotton mats, or other means acceptable to the engineer. This cooling with water shall be in addition to the initial sealing by membrane curing compound.

2011 CURING AND PROTECTION. Concrete shall be cured by protecting it against loss of moisture, rapid temperature changes and mechanical injury for at least four days after placement. Acceptable methods shall be moist curing, white polyethylene sheeting, liquid membrane-forming compounds, or a combination thereof. After concrete finishing operations

have been completed, the entire surface of the newly-placed concrete shall be covered by the curing medium applicable to local conditions and acceptable to the engineer. The contractor shall have the necessary equipment for adequate curing on hand and be ready to install prior to concrete placement.

Moist curing shall be accomplished by a covering of burlap or other approved fabric mat used singly or in combination. Curing mats shall be thoroughly wet when applied and kept continuously wet and in intimate contact with the surface for the duration of the moist-curing period. Burlap or fabric mats shall be long enough to cover the entire surface of the work and lapped at joints to prevent drying between adjacent sheets.

White polyethylene sheets shall be large enough to cover the entire surface of the work and shall be lapped not less than eighteen inches (18”). The sheets shall be adequately weighted to prevent displacement or billowing due to wind. Tear holes appearing in the material during the curing period shall be immediately repaired or replaced with material in acceptable condition.

White membrane curing compound shall be applied after finishing operations have been completed and immediately after the free water has left the surface. The surface of the work shall be completely coated and sealed with a uniform layer of the curing compound at a rate of not less than one gallon per 150 square feet. The compound shall not be thinned and shall be kept agitated to prevent settlement of pigment. On surfaces where forms are removed prior to the end of the specified curing period, the entire exposed surface shall be coated at the specified rate of coverage. If rain falls on the newly-coated surface before the film dries sufficiently to resist damage, or if the film is damaged in any other way, the contractor will be required to apply a new coat of compound to the affected area.

During cold weather concreting when the ambient air temperature is expected to drop below 40°F, a sufficient supply of burlap, straw, hay, or other blanketing material shall be provided along the work to protect the concrete and maintain a minimum temperature of 40°F in the concrete as measured on the surface. An approved moisture barrier such as wet burlap or plastic sheeting shall be placed on the concrete prior to placement of the blanketing material. This type of curing shall be maintained for a period of six days as the initial cure.

Sidewalks, curb and gutter, and miscellaneous concrete shall be protected and cured for a period of not less than seventy-two (72) hours after the placing of the concrete by covering with wet burlap or by the application of a membrane curing compound as specified above.

2012 FORMS. Forms shall be designed to produce hardened concrete having the shape, lines, and dimensions shown on the drawings. They shall be sufficiently tight to prevent leakage of mortar and shall be braced or tied to maintain the desired position, shape, and alignment during and after concrete placement.

Forms may be of wood or metal and shall be designed to permit easy removal without injury to the concrete. Forms for all exterior exposed surfaces which will be visible after backfilling shall be prefabricated plywood panel forms, job-built plywood forms, or forms that are lined with plywood or fiberboard. Forms shall be coated with an approved light oil to prevent concrete from adhering and shall be thoroughly cleaned and re-oiled before re-use.

Forms shall not be removed or disturbed until the concrete has attained sufficient strength to safely support all dead and live loads. Care shall be taken in form removal to avoid surface gouging, corner or edge breakage, and other damage to the concrete. The following table gives the approximate minimum time that forms shall be left in place.

AVERAGE AIR TEMPERATURE GREATER THAN	70°	60°	50°	40°
STRUCTURAL MEMBER	TIME IN PLACE (24 HOUR DAYS)			
Slab Shoring	10	12	14	21
Slab Forms	7	7	7	7
Beams Soffits and Shoring	10	12	14	21
Beam Side Forms	1	12	2	3
Wall Side Forms	2	2	3	4

2013 FINISHING FORMED SURFACES. Fins and other surface projections shall be removed from all formed surfaces except exterior surfaces that will be in contact with backfill. A power grinder shall be used, if necessary, to remove projections and provide a flush surface. Surfaces to be dampproofed shall have fins removed and tie holes filled, but no additional finishing will be required.

Tie holes in all formed surfaces shall be cleaned, wetted, and filled with an expansive cement mortar. Tie hole patches shall be left flush, sound, smooth, even and shall match the texture and color of the adjacent concrete.

Unless provided otherwise in the plans all exposed edges shall be beveled by using dressed, triangular molding, having three-fourths inch (3/4")sides.

2014 REPAIRING DEFECTIVE AND DAMAGED CONCRETE. Any concrete found not to be formed as indicated on the plans, or out of alignment or level, or having a defective surface, or damaged prior to acceptance of the project by the city, shall be considered as not conforming to the intent of these specifications and may be ordered removed and replaced by the contractor at his expense unless the engineer authorizes patching of the defective or damaged area. Surface defects such as ridges and bulges shall be removed by grinding.

Honeycombed and other defective concrete that does not affect the structural integrity of the structure shall be chipped out and the vacated area shall be filled. The methods used in this type of repair shall be approved by the engineer. Material used for patching shall be a non-shrink, non-metallic grout with a minimum 28-day compressive strength of 5000 psi or a similar material approved by the engineer. Prior to placement of the repair filling, the contact surface of the affected area shall be thoroughly cleaned of all loose and foreign material and shall be coated with an epoxy bonding agent.

Concrete repair work shall conform to Chapter 9 of ACI 301 and shall be performed in a manner that will not interfere with thorough curing of surrounding concrete. Repair work shall be adequately cured and protected from further damage.

2015 REINFORCEMENTS. The metal reinforcement shall be protected by the thickness of concrete indicated on the construction drawings. Where not otherwise shown, the thickness of concrete over the reinforcement shall be as follows:

LOCATION OF REINFORCEMENT	COVER
Surfaces where concrete is deposited directly against the ground	3 inches
Formed surfaces exposed to the ground, to water, or to weathering	2 inches
Beams, girder, and columns not exposed to ground, water, or weathering	1-1/2 inches
All surfaces other than those above	1 inch

Reinforcing steel shall be accurately placed and positioned on supports, spacers, hangers, or other reinforcing steel as approved by the engineer and shall be secured in place with wire ties or suitable clips. The minimum clear distance between parallel bars shall not be less than 1-1/2 times the diameter of round bars, except that in no case shall clear spacing between parallel bars be less than 2 inches or less than 1-1/2 times the nominal size of the coarse aggregate.

Splices in reinforcing steel will not be permitted at points of maximum stress. When it becomes necessary to splice reinforcing steel at points other than those shown on the contract drawings, the character and location of the splice shall be approved by the engineer. Welding or tack welding of reinforcement will not be permitted. Reinforcements upon which unauthorized welding has been done shall be removed and replaced as directed by the engineer. Spliced bars shall be placed in contact and securely tied together.

Metal reinforcement at the time concrete is placed shall be free from rust, scale, or other contaminants that will destroy or reduce the bond.

2016 CONSTRUCTION JOINTS. Construction joints shall be made at locations indicated on the drawings or specified, and shall conform to the requirements of ACI 318. When the contractor desires to make construction joints at other locations, he shall anticipate such changes far enough in advance of the construction operations to allow the engineer to investigate such changes and approve additional construction joints.

2017 EXPANSION AND CONTRACTION JOINTS. Expansion and contraction joints shall be at locations indicated on the drawings or as specified.

Contraction joints shall consist of planes of weakness created by forming or cutting grooves in the surface of the concrete. Formed grooves shall be made by depressing an approved tool or devise into the plastic concrete. Sawed joints shall be constructed by sawing through the surface of the concrete with an approved concrete saw. Sawing of the joints shall begin as soon as the concrete has hardened sufficiently to prevent excessive raveling.

Expansion joints shall be formed with pre-formed expansion joint filler of the non-extruding and resilient types which shall include the following; Cork, self-expanding cork, sponge rubber, cork rubber, and bituminous fiber. These materials shall meet the requirements of ASTM D994, D1751 and D1752.

2018 REINFORCED CONCRETE BOX FORMING SEQUENCE. Wall forms may be placed the day following the placement of the bottom slab, as long as care is taken to protect the slab against rough or abusive handling of forms and or placing equipment. The actual placement of concrete shall not occur prior to the fifth day after placing the bottom slab. Top forms may be placed with wall forms if the walls and top are to be monolithic construction, otherwise top forms are not to be placed until the third day after placing the walls. The actual placement of concrete for the top shall not occur prior to the fifth day after placing the walls (for base to top shoring) or until the walls have reached their design strength for slab forms shored by the walls. Wall forms shall remain in place a minimum of two days after the walls are poured. Supports for the top slab shall be left in place according to the schedule shown in this section, paragraph 2012--*Forms*.

The above guidelines for placing forms for reinforced concrete boxes are based on the use of standard forming procedures and with the use of concrete containing no admixtures to achieve high early strength. Variations in forming techniques and/or the use of high early strength concrete shall only be allowed after the contractor obtains the written approval of the city engineer.